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INSTRUCTION MANUAL

MODEL 240

REGULATED HIGH VOLTAGE SUPPLY

KEITHLEY INSTRUMENTS

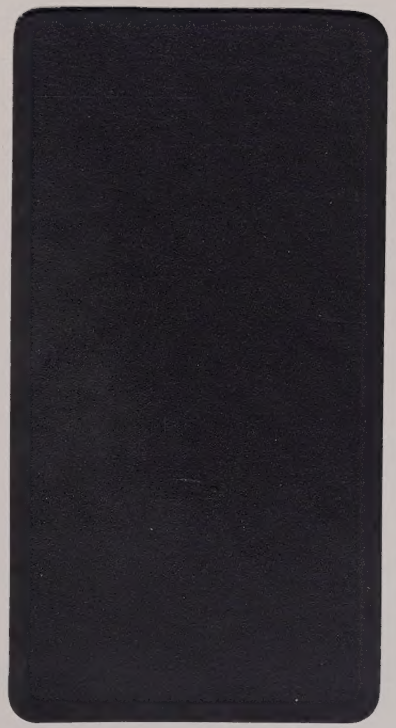

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TABLE OF CONTENTS

	Page
Section I. - Introduction.	1-1
Section II. - Specifications	2-1
Section III. - Operation	3-1
Section IV. - Circuit Description	4-1
Section V. - Maintenance	5-1
Replaceable Parts List	5-3
Voltage and Resistance Chart	5-7
Schematic Diagram.	5-9

SECTION I - INTRODUCTION

The Keithley Model 240 Regulated High Voltage Supply is a line operated source of dc potential. It provides constant, accurate output for safe and convenient testing of insulation, diode and capacitor leakage resistance, and it thus complements the Keithley line of electrometer equipment. The output can be set from zero to 1000 volts in increments of one volt.

The Model 240 may also be used as a general purpose laboratory voltage supply, furnishing excitation potentials to ion chambers and photocells, and supplying a buck-out potential for precise voltage measurements by the null method. It may be used as a stable dc potential in checking dc amplifier gains, calibrating meters, and in production testing. Used in conjunction with a Keithley electrometer, resistance over the range of 0.1 ohm to 10^{16} ohms can be measured.

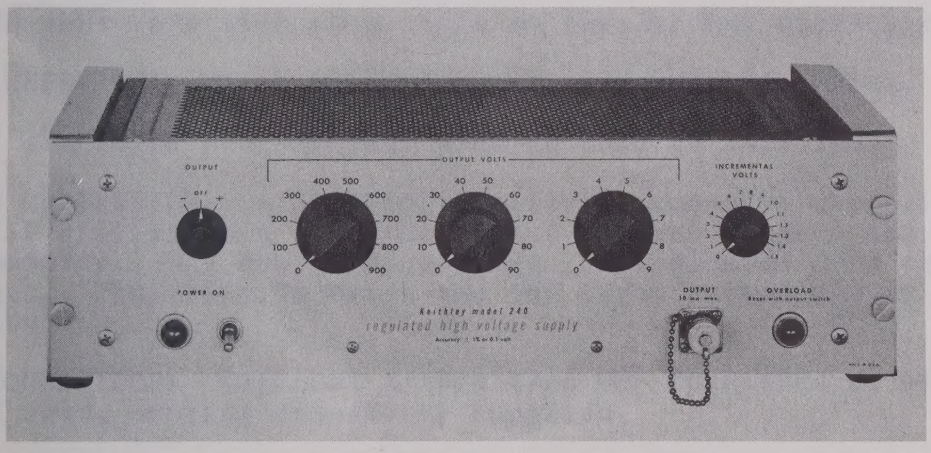


FIGURE 1. Keithley Model 240 Regulated High Voltage Supply equipped with end frames for bench use.

SECTION II - SPECIFICATIONS

OUTPUT VOLTAGE: Zero to 1000 volts, plus or minus, selected in one-volt steps with three calibrated front panel switches.

OUTPUT CURRENT: Zero to 10 milliamperes.

ACCURACY: Within 1% for outputs above 10 volts, and within 100 millivolts for outputs below 10 volts. A panel potentiometer is furnished to permit setting voltages to greater accuracy than possible with the panel switches.

OUTPUT IMPEDANCE: Less than 15 ohms.

LINE REGULATION: Output changes less than .05 volts ±.05% of output voltage for a 10% change in line voltage.

LOAD REGULATION: .05% for 0 to 10 milliamperes.

STABILITY: After a twenty minute warmup, within .05 volts +.05% the first hour or in any subsequent eight hour period if line voltage is constant within ±10%.

NOISE AND HUM: Are less than three millivolts RMS above 5 cps.

VOLTAGE RESETABILITY: Within the stability specifications.

RECOVERY TIME: 50 milliseconds from no load to full load.

OVERLOAD PROTECTION: A protective relay disconnects the output within 50 milliseconds when the output current exceeds about 12 milliamperes. The overload condition is indicated by a red panel light. The relay is reset and the light turned off by a panel switch.

OUTPUT CONNECTORS: Amphenol 83-798 type UHF furnished at both front and rear. Mating connectors supplied.

POWER REQUIREMENTS: 100-130 or 200-260 volts, 50-60 cps, 70 watts.

DIMENSIONS, WEIGHT: 5 1/4" high X 19" wide X 10" deep. Net weight 21 lbs.

NOTE: If even better Line Regulation and Stability are required, operate the 240 from a regulated source (Sola or equal).

SECTION III - OPERATION

General - The Model 240 Regulated High-Voltage Supply is shipped complete with tubes and fuse, and is accurately calibrated at the factory. Plug the power cord into a source of proper voltage and frequency. Unless otherwise specified, the unit is wired for 110v, 50-60 cps. For 220-volt operation, change the jumpers on the transformer primary as indicated in the schematic diagram. Turn the POWER switch to ON. Allow two minutes for the circuit to stabilize after turning it on.

Connections - UHF type output connectors are on the front and rear of the instrument. Due to the high potential available from the output, use a mating connector and polyethelene or teflon insulated cable for maximum user protection. When making connections with the power on, it is recommended that the OUTPUT switch be set to OFF.

Polarity - The output polarity may be chosen by setting the OUTPUT switch to the appropriate position.

Output Voltage - The output voltage is set with the three main dials on the panel. For small adjustments in the output voltage to facilitate making a critical measurement, the INCREMENTAL VOLTS knob can be employed. For more accurate voltage setting than possible with the panel dials, connect an accurate voltmeter to the output connector and set the desired voltage with the main dials and the INCREMENTAL VOLTS potentiometer.

For the accuracy specification to hold, the INCREMENTAL VOLTS must be set to zero.

Overload Protection - Overload protection is provided at a current of about 12 milliamperes. If the current exceeds that amount, the output is disconnected within 50 milliseconds; the circuit can then by reset with the OUTPUT switch on the front panel. In this way, not only is the instrument protected, but in most cases the component being tested as well.

SECTION IV - CIRCUIT DESCRIPTION

Figure 2 shows the simplified circuit diagram, while DR 12282C, enclosed at the back, gives the circuit details.

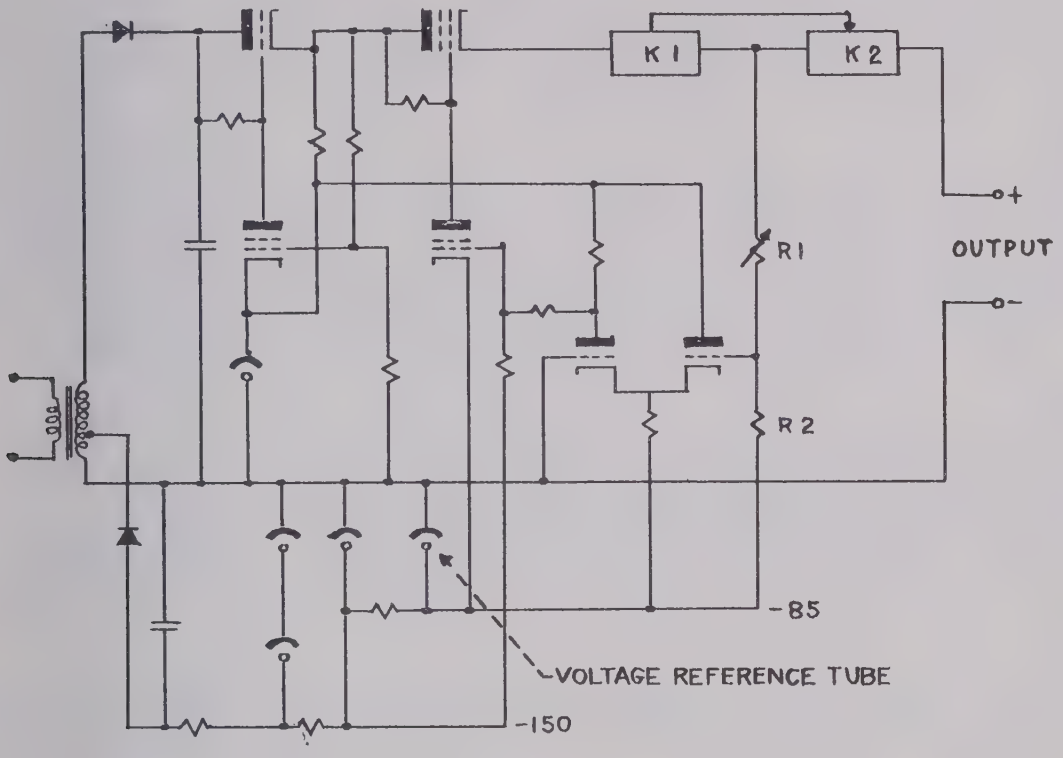


FIGURE 2

Refer to Figure 2. Two cascaded electronic series-regulators furnish a high degree of load and line regulation. The first regulator reduces the effect of input voltage change, while the second regulator provides the means for varying the output voltage and provides a low output impedance and very close regulation. Resistors R1 and R2 determine the output voltage by referencing it to a selected, aged premium VR tube. The current supply to the reference tube is doubly regulated. Relays K1 and K2 are overload protectors, disconnecting the output within 50 milliseconds.

Refer to DR 12282C. The high-voltage output of transformer T1 is rectified and supplied to the plate of V2, the series tube in the pre-regulator. V4 compares a fraction of the pre-regulated voltage from divider network R110 to R113 to the 150 volts of V6. This standard regulator supplies approximately 1300 volts to the final regulator.

The final regulator consists of series tube V3 and difference amplifier V5 and V11.

V11 compares the potential between the minus side of the supply and the mid-point of the divider formed by resistors R129 to R158, chosen by the voltage controls on the panel, and resistors R145 and R127, going to the minus 85v reference potential supplied by V10. Since the action of the negative-feedback circuit is to maintain pin 7 of V11 at ground, the output voltage must assume whatever value necessary to satisfy this condition. For example, since the resistance from the grid to the minus 85 volt reference (R148, R127) is set so that 100 microamperes must flow to have pin 7, V11 at ground potential, the side of the divider going from pin 7, V11 to the plus output, must also be of a value which will allow 100 microamperes to flow from B-plus to the negative reference since the tube grid draws negligible current. Therefore, if the current is fixed, the output voltage is a linear function of the resistance from B-plus to pin 7, V11. With the values used here, the output voltage changes by exactly 100 volts per megohm of resistance added by switches S3, S4, S5, and the INCREMENTAL VOLTS control. When the main dials are set at zero, there is no resistance between the cathode of V3 and the divider return to the input grid of V11. Thus, the output and feedback points are tied together and this is the condition for zero volts output. ZERO control R116 adjusts the common cathode current in V11 so that both grids may be set at zero volts. The CALIBRATE control, R127, is adjusted so that exactly .1 milliampere flowing through R148 and R127 produces a voltage drop equal to the negative return voltage from V10.

Overload protection is provided by relays K1 and K2. The current sensing relay, K2, energizes relay K1 when the output current rises to about 12 milliamperes. K1 disconnects the output terminal from the voltage supply, holds itself closed through the first section of S2, and lights the red overload light. Switching the OUTPUT switch, S2, to OFF opens the self-locking loop of K1.

SECTION V - MAINTENANCE

BE EXTREMELY CAREFUL that the Regulated Voltage Supply is disconnected from the power line when unscrewing the top or bottom covers. Many circuit components are 1000 volts above ground, and if the output polarity is negative, the negative side of the circuit is 1000 volts below ground. Therefore, do not assume that it is safe to touch any part of the circuit when the power is on.

Tube Replacement

With the exception of V10 (0G3) and V11 (12AX7), all tubes can be replaced with jobber stock tubes. A replacement for V10 (0G3) should be aged for 300 hours. A replacement for V11 should be selected for low drift, hum and noise. Amperex ECC 83-12AX7 is recommended. Both tubes, aged and selected, are available from Keithley Instruments with stock numbers EV 0G3-240 (V10) and EV 12AX7-240 (V11).

Recalibration

The zero setting can be readjusted with potentiometer R116, mounted on the channel just behind the front panel. Set the OUTPUT VOLTS switches and the INCREMENTAL VOLTS potentiometer to zero. Connect a voltmeter to the output terminals and adjust R116 until the output reads zero.

The voltage calibration can be set with potentiometer R127. Connect an accurate voltmeter to the output terminal. Set the OUTPUT VOLTS switches to the highest voltage which may be read by the voltmeter and adjust R127 until the voltmeter reads the dial setting.

The settings will be no more accurate than the standardizing meter; and it is well to let the instrument warm up for about an hour before recalibrating. Recalibration will be necessary only after replacement of V10 or V11.

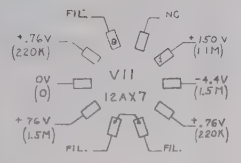
Circuit Desig.	Description	Part No.
R101	1K ohm resistor, deposited carbon, 1 watt, 10%	R2-1K
R102	5K ohm resistor, wire wound, 25 watt, 5%	R45-5K
R103	470K ohm resistor, deposited carbon, 1/2 w, 10%	R1-470K
R104	8.2K ohm resistor, deposited carbon, 2 watt 10%	R3-8.2K
R105	5K ohm resistor, wire wound, 5 watt, 5%	R4-5K
R106	80K ohm resistor, wire wound, 10 watt, 3%	R30A-80K
R107	80K ohm resistor, wire wound, 10 watt, 3%	R30A-80K
R108	8.2K ohm resistor, deposited carbon, 2 watt, 10%	R3-8.2K
R109	10K ohm resistor, wire wound, 5 watt, 5%	R4-10K
R110	333K ohm resistor, deposited carbon, 1 w, 1%	R13-333K
R111	333K ohm resistor, deposited carbon, 1 w, 1%	R13-333K
R112	333K ohm resistor, deposited carbon, 1 w, 1%	R13-333K
R113	120K ohm resistor, deposited carbon, 0.5 watt, 1%	R12-120K
R114	312K ohm resistor, deposited carbon, 0.5 w, 1%	R12-312K
R115	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R116	100K ohm potentiometer, composition	RP15-100K
R117	180K ohm resistor, deposited carbon, 0.5 watt, 1%	R12-180K
R118	5K ohm resistor, deposited carbon, 0.5 watt, 1%	R12-5K
R121	5M ohm resistor, deposited carbon, 0.5 watt, 1%	R12-5M
R122	1.667M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1.667M
R123	700K ohm resistor, deposited carbon, 0.5 w, 1%	R12-700K
R125	120K ohm resistor, deposited carbon, 0.5 w, 1%	R12-120K
R126	Not Used	
R127	70K ohm potentiometer, wire wound, 4 watt	RP1-70K
R128	220K ohm resistor, deposited carbon, 0.5 watt, 1%	R12-220K
R129	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R130	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R131	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R132	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R133	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R134	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R135	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R136	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R137	1M ohm resistor, deposited carbon, 0.5 w, 1%	R12-1M
R138	600K ohm resistor, deposited carbon, 0.5 w, 1%	R12-600K
R139	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R140	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R141	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R142	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R143	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R144	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R145	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R146	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R147	100K ohm resistor, deposited carbon, 0.5 w, 1%	R12-100K
R148	*800K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K

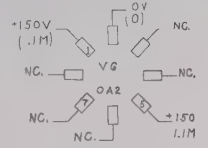
Circuit Desig.	Description	Part No.
R149	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R150	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R151	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R152	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R153	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R154	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R155	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R156	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R157	10K ohm resistor, deposited carbon, 0.5 w, 1%	R12-800K
R158	15K ohm potentiometer, wire wound	RP19-15K
R159	1K ohm resistor, composition, 0.5 watt, 10%	R1-1K
R160	3 ohm resistor, W.W., 5 watt, 10%	R4A-3
R161	100 ohm resistor, wire wound, 5 watt, 5%	R4A-100
R162	500 ohm resistor, wire wound, 5 watt, 5%	R4A-500
C101	20mf capacitor, tubular electrolytic, 600 VDCW	C35-20
C102	2mf capacitor, oil filled, 2000 VDCW	C42-2
C103	20mf capacitor, tubular electrolytic, 450VDCW	C8-20
C104	0.02mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.02
C105	0.02mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.02
C106	0.02mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.02
C107	0.01mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.01
C108	0.02mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.02
C109	0.01mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.01
C110	.22mf capacitor, molded plastic tubular, 1600 VDCW	C54-.22
C111	0.02mf capacitor, ceramic disc, 600 VDC, 10%	C22-0.02
C112	0.033mf capacitor, molded plastic tubular, 1600 VDCW	C43-0.033
D101	Selenium rectifier, 125V, 65 milliampere	RF18
D102	Selenium rectifier, 125V, 65 milliampere	RF18
D103	Selenium rectifier, 125V, 65 milliampere	RF18
D104	Selenium rectifier, 125V, 65 milliampere	RF18
D105	Selenium rectifier, 125V, 65 milliampere	RF18
D106	Selenium rectifier, 125V, 65 milliampere	RF18
D107	Selenium rectifier, 125V, 65 milliampere	RF18
D108	Selenium rectifier, 125V, 65 milliampere	RF18
D109	Selenium rectifier, 125V, 65 milliampere	RF18
D110	Selenium rectifier, 125V, 65 milliampere	RF18
D111	Selenium rectifier, 125V, 65 milliampere	RF18
D112	Selenium rectifier, 125V, 65 milliampere	RF18
D113	Selenium rectifier, 125V, 65 milliampere	RF18
D114	Selenium rectifier, 125V, 65 milliampere	RF18
D115	Selenium rectifier, 125V, 65 milliampere	RF18

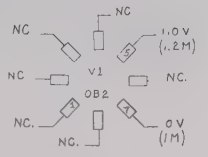
Circuit Desig.	Description	Part No.
D116	Selenium rectifier, 125V, 65 milliampere	RF18
D117	Selenium rectifier, 125V, 65 milliampere	RF18
V1	0B2 Voltage Regulator, glow discharge	EV 0B2
V2	6CM6 electronic tube	EV 6CM6
V3	6BG6 electronic tube	EV 6BG6GA
V4	6BG6 electronic tube	EV 6BG6GA
V5	6BG6 electronic tube	EV 6BG6GA
V6	0A2 Voltage Regulator, glow discharge	EV 0A2
V7	0A2 Voltage Regulator, glow discharge	EV 0A2
V8	0B2 Voltage Regulator, glow discharge	EV 0B2
V9	0A2 Voltage Regulator, glow discharge	EV 0A2
V10	0G3 Voltage Regulator, aged for 300 hours	EV 0G3-240
V11	12AX7 electronic tube, Amperex ECC83-12AX7, specially selected	EB12AX7-240
DS1	6.3 volt, .015 ampere, No. 47 bulb, miniature bayonet base	PL4
DS2	6.3 volt, .015 ampere, No. 47 bulb, miniature bayonet base	PL4
K1	Potter and Brumfield relay No. LBS/9mA/2500 ohm	RL5
K2	Potter and Brumfield relay No. AB11A/6.3v/1.3 ohm	RL6
F1	Type 3AG 1.5A, 250v	FU8
S1	Off, on switch	SW4
S2	Polarity switch	SW27
S3	Range switch	SW28
S4	Range switch	SW28
S5	Range switch	SW28

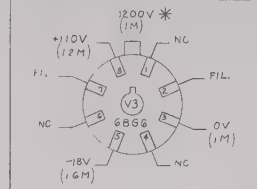
*Nominal value adjusted at factory.

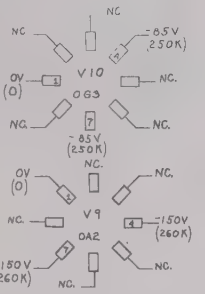
PC-24-A

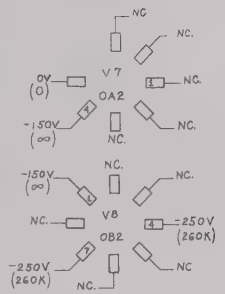


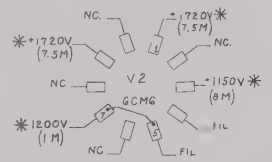


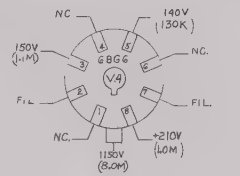


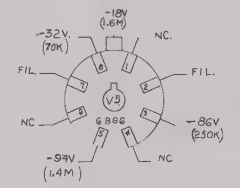












MEASUREMENTS MADE FROM TUBE PIN TO CHASSIS GROUND WITH CONTROLS SET AS FOLLOWS:
OUTPUT ON PLUS
OUTPUT VOLTS ON ZERO
INCREMENTAL VOLTS ON ZERO
POWER ON

VOLTAGES INDICATED WITH AN ASTERISK ARE MEASURED WITH A 50,000 OHMS PER VOLT DC. VOLTMETER. ALL OTHER VOLTAGES ARE MEASURED WITH AN 11 MEGOHM (INPUT) V.T.V.M.

ATTENTION:
THE FILAMENTS OF V2 AND V3 ARE CONNECTED TO THEIR CATHODES AND THEREFORE ARE AT HIGH DC POTENTIAL. INSULATE THE VOLTMETER FROM GROUND WHEN MEASURING FILAMENT AC VOLTAGES.

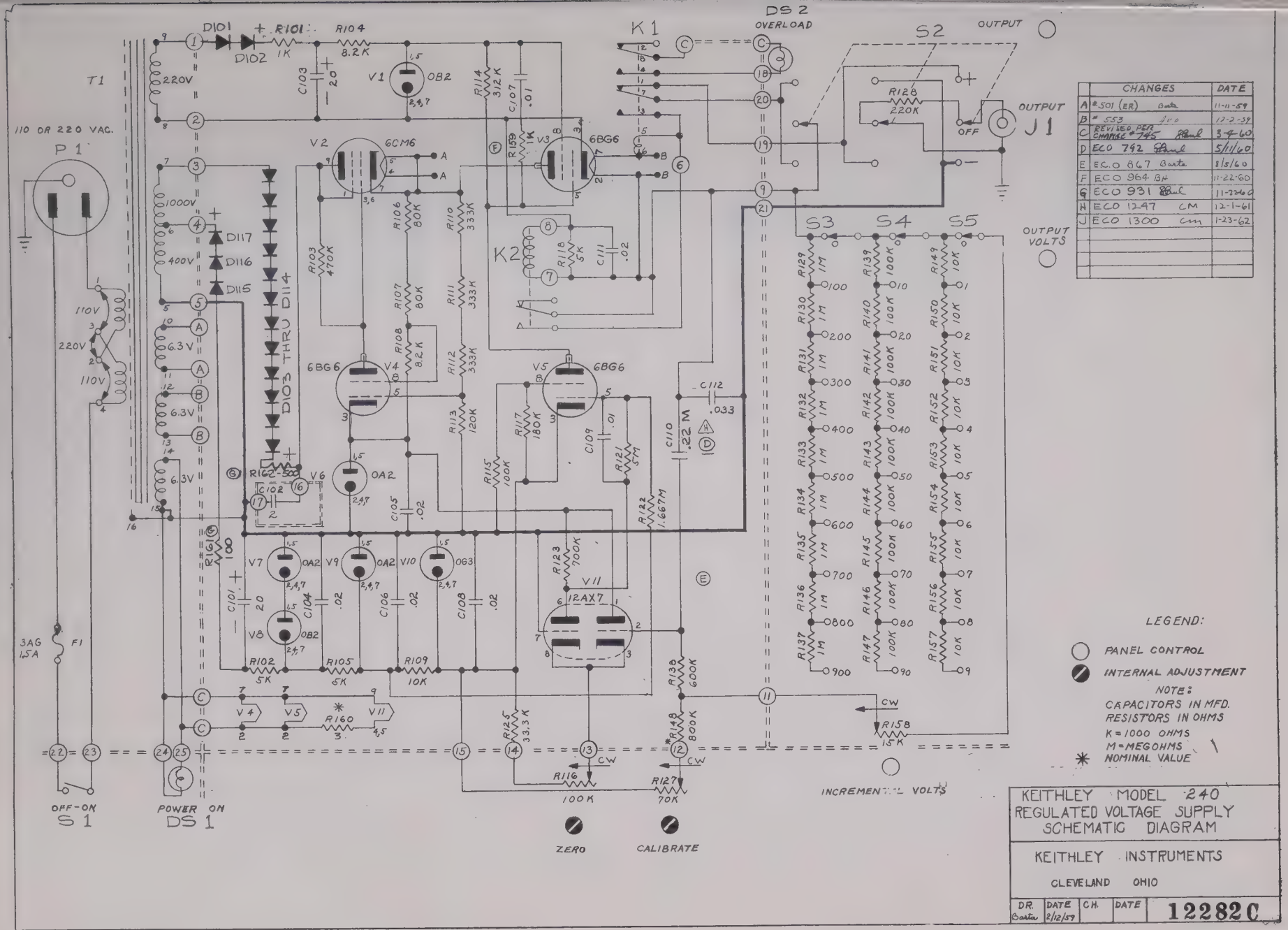
REVISIONS		
DESCRIPTION	BY	DATE
PER DCN #554	MB	12-4-59

MODEL 240
VOLTAGE AND RESISTANCE CHART

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

DR	DATE	CH.	DATE
Gaskill	11-18-59		

DR. 12900 D



	CHANGES	DATE
A	#501 (ER) Barta	11-11-59
B	# 553 "	12-2-59
C	REVISED PER CHANGE #745 Paul	3-4-60
D	ECO 792 Paul	5/11/60
E	ECO 847 Barta	8/5/60
F	ECO 964 BH	11-22-60
G	ECO 931 Paul	11-22-60
H	ECO 1297 CM	12-1-61
J	ECO 1300 CM	1-23-62

LEGEND:

- PANEL CONTROL
- INTERNAL ADJUSTMENT

NOTE:
CAPACITORS IN MFD.
RESISTORS IN OHMS
K = 1000 OHMS
M = MEGOHMS
✱ NOMINAL VALUE

KEITHLEY MODEL 240
REGULATED VOLTAGE SUPPLY
SCHEMATIC DIAGRAM

KEITHLEY INSTRUMENTS
CLEVELAND OHIO

DR.	DATE	CH.	DATE	
Barta	2/12/59			122820

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof, except tubes, transistors, fuses, and batteries, which, within a year after shipment to the original buyer, proves defective on examination.

DAMAGE IN SHIPMENT

Be sure to include the instrument model number and serial number in all communications.

If the instrument is damaged when received, or fails to operate properly, a claim should be filed with the carrier. Upon receipt of the claim agent's report, we will inform you regarding repair or replacement.

REPAIRS

When returning an instrument for repair or recalibration, it should be securely packed against shipping damage and sent to the factory, freight prepaid. A brief letter describing the difficulty should accompany the instrument.

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE CLEVELAND 6, OHIO